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Natural Science in the Secondary School: A Digest of Recent Literature

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I. Historical

If we glance back over the history of natural science, we find the early Greek scholars concerned with problems of astronomy and anatomy. These were subjects which gave full play to their fondness for argument. Because of the practice of the ancient Greek in disputation, it became necessary for him to go back again and again to the facts of observation to check and confirm his own hypotheses or to refute those of his opponents. Thus there grew up during the course of five or six centuries a scientific method and a body of truly scientific knowledge of no inconsiderable value. In sciences such as physics and chemistry, however, they accomplished practically nothing because, to them, these were fields of knowledge which contributed to the industries and trade, and as such were the concern only of slaves and menials.

Following the Greek ascendency, little attention was given by scholars to the study of science and all that had been accomplished by the Greeks lay neglected. The early Christians, concentrating on the thought of a future life, had almost supreme disregard for the forces of nature. Their dogmatic theology, enforced by the Church during the Middle Ages, kept those who had the leisure and the means for intellectual pursuits from investigating in scientific fields.

It was not until after the German invasion, with the revivifying of industry and trade, that there rose up a group of scholars interested in the facts and phenomena of nature. The names of Columbus, Copernicus, Paracelsus, Galileo and Newton are sufficient to bring to our minds the tremendous development

of the physical sciences which began with the fifteenth century. Other names might easily be mentioned to remind us that there began to be taken at this same time great strides in the advancement of botany, zoology and physiology.

The scientific field of knowledge, developed by independent scholars, continued practically a private and personal realm of study in all countries until the latter part of the eighteenth century. In America, the early Latin Grammar School had no place in its curriculum for natural science. It was with the development of the academy, a movement which started in about 1780, that subjects other than the classics made their appearance in the curriculum. The public high school, with its development, adopted for the many what the academy had offered to the few, and has continued to have offerings in science up to the present day.

The science subjects first offered in the Boston Public Latin School included geography, navigation, and natural philosophy (physics) including astronomy. Since 1820, public schools have offered chemistry, botany, physical geography, zoology, meteorology, geology, anatomy, physiology and hygiene in addition to those studies offered by the earliest schools of the country. At first, in America, science study was considered of value for its informational side alone; later pure science was stressed; and more recently emphasis has been placed upon the practical values of the applications of science.

Within the past thirty years there has been an apparent falling off in the study of the natural sciences in our secondary schools with a corresponding increase in the proportion of students engaged with the humanities. The curve of distribution of high school pupils in subject studies, derived from statistics in the report of the United States Commissioner of Education for 1916, shows a downward trend for astronomy, chemistry, physics, physiology and physical geography since 1890. This may be explained in part by the shift of students with scientific interests to other subjects, like general and applied science for which no curves can yet be drawn, and by the flocking of girls to such studies as cooking and sewing which are often grouped as household "science" and which pass for the one unit of science often required in the students program of four or five units each year. Further explanation of this downward curve may be found in the fact that during this time the great increase in

high school enrollment has been in the rural high schools. The sort of course in vogue there has determined, therefore, in large measure, the decreasing enrollment in various science subjects.

II. REASONS FOR THE STUDY OF SCIENCE.

This decrease in the percentage of students studying science, be it real or imaginary, should make us seriously consider the reasons for the study of this type of work in our secondary schools. Alexander Smith has summarized the reasons somewhat as follows:

(1) Science gives training in careful and intelligent observation. Altho this sort of training is common to all forms of scholarship it is found particularly in science which directs attention to material objects. In the words of President Eliot, "The student of natural science scrutinizes, touches, weighs, measures, analyzes, dissects and watches THINGS". This type of training is much more valuable for the future citizen than the study of books alone.

(2) Science gives training in the organization of observations by comparison and induction. As with the first point, this quality is not possessed by science alone, but is also held by other subjects. Science, however, may develop this function to a greater extent than languages, for instance, for with science it is possible to study the thing itself for first hand information, to establish every fact with conclusiveness and exactness, and to test every inference and hypothesis by renewed comparison with facts.

(3) Science demands the use of the imagination and at the same time, its control. The imagination is a good servant but a bad master. The true scientist will test the hypothesis of his imagination by the concrete materials of his experience and develop thereby a useful adjunct to his educational tools.

(4) Science gives training in efficient habits of thought and in the development of an unbased judgment. Other branches of knowledge are so filled with human opinions, permeated by conventional standards, and all through show so strongly the stamp of human workmanship that unprejudiced judgment is hard to attain. The material of the sciences favors self-elimination in the achievement of a dispassionate result.

(5) Another reason for the study of science is to be found in the value of the information which the science itself imparts.

Information is useful to any individual only when it can be applied, either immediately or ultimately, to some problem that appears vital to him. The public is beginning to recognize that a scientifically trained mind applied to grading a roadbed, managing a loom, or operating a dairy plant is as dignified and quite as respectable as when intellect is exploited for the purpose of clearing a known criminal from the penalties of the law. Not only is this information valuable in itself, but it assists in holding the interest of the majority of pupils who would not be so much attracted by a purely disciplinary study.

Other subjects may claim to provide discipline under every one of these heads, but in each case science gives a particular variety of this discipline which is distinctive.

Some objections have been raised to the inclusion of science among secondary school studies. It is said that the method of science is so rigorous and exact that it unfits men for dealing with human questions which have not the same cleancut qualities. Whether or not this be true of specialists (which we doubt) it certainly is not true of the secondary school student, whose scientific work is of an elementary character and occupies but a fraction of his time. It is said also that the study of science has a distinctly narrowing influence. This may be so when taught by a poor teacher, but no more so than any other study taught under the same conditions.

III. The Sequence of Science Studies.

If, then, we are convinced that science has a value sufficient to warrant us in including some in the curriculums of our secondary schools, we must decide which sciences are of most worth and in what sequence they most profitably can be offered.

Present day educators do not place astronomy or geology in practically any curriculum. Few schools are inclined to provide a good working telescope for a class in astronomy; and without the telescope and a good working command of mathematics there is scarcely enough worth while material to make up a year's course. Very elementary astronomy may be introduced from time to time into a course in general science and enough of a groundwork given there to enable any interested person to pursue the study for himself in later years with a considerable amount of benefit and enjoyment.

Geology, likewise, for the secondary student seems to have found no secure place in the school programs for a number of years. Its interests and values for the adolescent have been seriously questioned and doubtless for a number of years to come the geology of our scientific program will be the technical geology of the college and university course. However, certain phases of geology, and a good deal of what is most valuable in meteorology from the standpoint of young students may be introduced in the general science course.

The natural sciences, some or all of which, are commonly found in the curricula of secondary schools of the present day, are chemistry and physics, some life science (botany, zoology, biology, physiology, et cetera), an earth science (physiography, agriculture or geography) and general science with their various modifications and extensions. Commissioner Claxton, who would include astronomy in the curricula or secondary schools, says: "We need enough science put into our curriculum for children to learn that this world is ruled by laws........that they will observe what is going on........and interpret what they see".

In thinking of the sequence of science studies in secondary schools of the six-three-three plan it must first of all be recognized that any plan for one particular kind of school might not be practicable elsewhere and that the demands of urban and country schools, of classical, technical, and vocational schools will surely be somewhat and are likely to be entirely different. Twiss says in his "Principles of Science Teaching", "The best order for the different science studies has never been tested out and determined. That it ever will be so tested out or indeed that there is any one order that is demonstrably best for all schools is very unlikely." It is his thought, however, that biology and geography may well be studied in the earlier years of the high school course and physics and chemistry in the later, for this general order has come very generally to prevail, and the best textbooks on these subjects that are now on the market are planned with this order in view.

An examination of the curricula of a large number of schools gives not much more help for the solution of this problem than is contained in the above general observation of Professor Twiss. On the assumption that geography and nature study have been offered and well taught in grades one to six, an order for some

of the science subjects of the junior-senior high school is suggested below and then in the discussion which follows the modifications and additions that may be made to this core to meet particular needs are indicated.

Grade 7	General Science
Grade 8	General Science
Grade 9	Civic Biology
Grade 10	Geography
Grade 11	Physics
Grade 12	Chemistry

Of the sciences in this list, those of the first three years are the most recent arrivals in the science fold and so perhaps need justification, not only for their position but also for their content.

General science is not a new subject its materials are not new. It differs from former science work in its point of view; in its methods of organization and attack and in its selection of material. It is designed to give to that great mass of students that has little or no need of training in the special sciences and that will not go on into the senior high school, an insight into the broad general principles of science, a method of thinking, and a self-reliance in solving simple scientific problems which will be of value to them in their vocational and avocational pursuits.

Special science had its trial in the early years of the high school and failed. In large measure, it failed to interest the pupil; science teachers regarded it as more or less of a failure; superintendents and school boards and especially thinking patrons lost faith in it. The reason most commonly given for this is that, though for the fullest understanding of any one science there must be an accompanying knowledge of the other sciences, yet in the high school the sciences have all been pigeonholed in various semesters or years and unrelated to each other. It is also recognized that another thing prejudicial to the full success of science teaching in the high school lies in the fact that the first year student lacks sufficient apperceptive basis for any special course dealing with the theories and problems of pure science. He is, therefore, apt to be repelled by such work. Even when the first year work includes many applications of the science studied to every-day life, it is apt to prove unattractive, for the pupil lacks sufficient information to fully appreciate or understand many of these applications until he has had some-

thing of the other sciences. Yet the teacher cannot take time, in a special science course, such as botany, for example—crowded with materials to be gone over in a limited time—to introduce and demonstrate and explain chemical and other facts which the pupil needs to know in order to understand fully certain applications of botanical facts. Moreover, first-year students are naturally what we may call superficial. Their interests spread over a large area, but do not go very deeply. They are interested in the many wonderful and fascinating things in the world about them and wish to understand them. They like to experiment, to see demonstrations. They like studies related to life. But work limited to a single special science, and but vaguely related to life, does not appeal to them.

Inasmuch, therefore, as the special sciences are in general not holding their own in the high schools and as no one of them proves attractive or beneficial to first-year students, general science has been made the first step in an attempt to secure some sort of a reorganization. If general science is to be of educational value it must consist of well-organized units of instruction must have unity and logical development. It must attack the problem at the logical point of beginning, the first year, and by the only method that ought to appeal to scientific men—experiment. General science is frankly experimental but it is not a random nor an uncontrolled experiment.

It is necessary that science work be shaped to provide a path for the training of research workers; but we must not lose sight of the fact that it is equally necessary that the needs of the masses of the young people, preparing, not for research work, but for the ordinary activities of life, receive some consideration. Much of the material which has thus far appeared in texts called "general science" consists of clippings from the specialized sciences. In many cases little or no unifying idea is evident. A course based on such a text may well be called a "spineless wonder".

When we recognize these fundamental principles and reorganize and adapt our high school science courses to them; when we recognize the needs of the millions of young people who will never see the inside of a college or university or even complete a high school course; when we give up the idea that we must attempt to make great scientists out of all the boys and girls of the generation, or, failing this, crowd them from the high

school; then and not until then may we hope to see science in the high school assume the relative position which its importance in modern life justifies.

As must inevitably be true of any new movement, it always has its objectors. General science, however, has been rather universally accepted by American school men as an advance step in the path of improved efficiency. Three objections which have been raised to general science are that it is fragmentary; is superficial; and does not take individual differences of students into account. It has been said that a mosaic made up of fragments of information breaks up all natural connections and forbids the development of those ideas which relate and hold facts. The relations suggested by a mosaic are purely artificial and never can develop a body of knowledge as contrasted with a body of facts. Since facts are the groundwork of science, any science study must be informational and a very large amount of information is defensible in a first year course. Another critic has objected to general science on the ground that it is composed of composite brief abstracts from several sciences which are compressed into relatively unimportant brevity, shallow superficiality, and pretentions vacuity. Whatever justification there may have been for such criticism of the earlier courses, it is commonly believed that general science, as now organized, offers no justification for such statements. True it is that many of the text books now used are simply compressed sections from a few of the special sciences. The newer texts and the modern courses of study in general science, however, are so organized and the facts are so woven together as to make a connected whole without any thought of the particular science or sciences which are involved. Our thinking has got away from the landmarks of the special sciences, and has blazed a new trail with the capacities and interests and science needs of the younger pupil as guide posts. The third objection—that general science does not make allowances for individual differences—may be valid if its study be required of all pupils. This much may be said in its defence, however, that is is designed as a course of exploration that the pupil may determine his interests. No project is so long but that a pupil may work it through without becoming entirely disgusted with science as a whole, nor so short as to be valueless for content and suggestion. By it a permanent interest in scientific information and study is often awakened and

the pupil encouraged to do work in specialized sciences which otherwise would have had no attraction for him.

The suggested scheme places general science in the seventh and eighth grades at a time when the spirit of scientific curiosity, which is so strong in children of that age, ordinarily is being starved. It naturally follows the nature study of the earlier grades developing, amplifying and extending the ideas there gained with special reference to their economic and practical values. In some school systems it may seem best to offer only one year of such work, in the eighth grade, yet the rate of progress, which is necessarily slow in these early years, indicates the advisability of extending the work through two grades.

General science naturally and easily leads into any one of the later sciences. If it is to be immediately followed by biology, it will be so organized as to serve as a satisfactory introduction to this subject, so that the transition from one course to the other will be easy and natural.

The outline suggested biology as the science of the ninth grade. Civic biology is admirably adapted to the interests, capacities and needs of students of that age. It also forms an admirable introduction to the more difficult and usually more highly organized science courses of the upper three years. More important still, if well taught, it imparts the information and arouses the interest that every good citizen should have concerning the vital biological problems that daily press on every community for solution, and if given in the third year of the junior high school more students will come under its influence than if given in any higher year.

Civic biology is a recent name in school terminology. Its content is not yet standardized and probably never will be; for this content is somewhat different in the city from what it is in the country, and it also varies considerably according to the kind of region in which the students live. It is somewhat different in the Southern States from what it is in the Northern; and is still more different in Utah and Nevada from what it is in New York City or New England. It gives the kind of knowledge that every citizen should have in order to understand his own body and guard it against injury and disease, and to keep the mind and body wholesome, clean and efficient. It also gives the kind of knowledge and training that makes one acquainted with the plant and animal forms that are most necessary and useful

to the people of the community, and what must be done to conserve them, improve them, and make the most economical use of them. But there are animal and plant forms that are tremendously destructive to human life and health and that destroy each year untold millions of dollars worth of food products and other vegetable and animal life. Civic biology gives knowledge of the life histories and habits of these destructive plants and animals and of the methods of community cooperation that must be adopted to exterminate them.

Botany and zoology, or either of them alone, is found as a year's course in many schools and nothing can be said against such an arrangement if they are effectively taught. However, if the course in civic biology be adopted for the ninth grade, the students will get from it a much more vital knowledge of those portions of botany and zoology that are most necessary and useful to the community and will not be obliged to leave school without that training of which no intelligent citizen should be destitute. For small groups of students in the senior high school with particular biological interests specialized courses in botany or zoology may be offered as substitutes for physics or chemistry.

With the beginning of the senior high school period there is greater need and better opportunity for differentiation in the science program. The geography which is in mind for the tenth grade may well be called general geography. It is not home geography, or locational, or physical, or causal, or regional, or political, or economic geography; but it embraces the most essential and vital features of all of these. It grows very naturally out of civic biology; it prepares the way for an appreciation of history. It has been classified here as a natural science; but it is just as truly a social science.

If the introduction of general science into the seventh and eighth grades has crowded out geography from the curricula of those grades, this is certainly the place to reintroduce it. It is impossible to expect that sufficient geography can be taught before the junior high school period, or that enough more can be gathered as incidental to history in the high school to give to the high school graduate the geographical equipment that he should have.

Geography offers opportunity for widening the horizon of the student in matters of everyday interest in the world about him. It is essentially a survey subject. From the days when

ancient Pytheas sailed the northern seas, down to the last brave dash for the pole, the keynote of geography has been discovery and exploration. No subject is better fitted to train the powers of observation, or to challenge the student to clear logical thinking. All these virtues inhere in geography as it may be studied in the grades, and in a peculiar way they belong to geography as it may be developed in the high school.

To anyone who has tried to follow in the newspapers and magazines the world important events during and since the World War period, the need of more geographical knowledge has been easily apparent. General geography in the tenth grade can be so modified as to meet the needs of particular groups of pupils; students intending to enter commercial occupations may have emphasized the phases of geography most important to their future needs for students intending to enter college its political and economic phases would have a direct propaedeutic value.

There is little question but that physics and chemistry should come near the end of the high school course. These sciences require patient, intelligent and forethoughtful manipulation which is favored by maturity rather than by youth. Teachers, however, are not of the same mind as to the order in which they should appear in a curriculum. It often is true that a teacher, a specialist in some one science subject, is particularly anxious to have that subject come as late in the student's secondary school life as possible. The reason, either conscious or unconscious, for such an arrangement probably comes from the teacher's desire to utilize the student's maturity and working knowledge of the other sciences and training in their methods for a more exacting, extensive and intensive course in the subject in which he is most interested.

In 1893 the Committee of Ten of the National Education Association recommended that chemistry and physics be taught in the last two years of the high school in the order named, placing physics in the fourth year because of its alleged greater difficulty and because of the supposed need of more previous mathematical training. A little later, the National Education Association's Committee on College Entrance Requirements recommended physics in the third year and chemistry in the fourth. This recommendation has been almost universally followed.

Every science contributes something in both content and method to every other. Physics becomes a better course if taught after chemistry; and likewise, chemistry, if after physics. If general science is taught in the first years of the junior high school, facts from each of the sciences as are comprehensible and useful to pupils of that age are given. If the teaching be effectively done, teachers of specialized sciences in the later years of the senior high school can count on some elementary knowledge of the other sciences to build upon.

The arguments for the precedence of chemistry are three; for the precedence of physics, two. It has been said that the greatest amount of mathematical training possible should be secured before beginning the study of physics. Authorities do not seem to be at all unanimous on this point, however, for one of them says, "There is no mathematics needed in elementary physics even as it is now, except the simplest algebraic equations with one unknown, and the simple geometrical proposition of the proportionality of the sides of similar triangles". Moreover, at least one urban high school in Massachusetts has taught physics in the tenth grade for a considerable term of years with marked success. In the second place, it is frequently maintained that chemistry may and should be taught more simply than physics. Every subject should be taught simply, i. e. to avoid obscurity and confusion in the mind of the student. But the simplification of chemistry usually means the removal of most of the science along with the difficulties. In the third place, it is argued that the manipulation in chemistry is simpler than in physics. This would be true of simplified chemistry, but if the teaching of chemistry attempts to include the fundamental principles of the science, as the teaching of physics does, it need not suffer from the lack of experiments requiring skill, patience, and knowledge.

On the other hand it may be argued that the subject matter of physics is more simple and more obvious to the senses than chemistry and derives more abundant material for illustration from the experiences of everyday life than does chemistry. A great part of physics relates to phenomena wherein the bodies concerned and their behavior are directly perceptible to the senses at every stage of the experiment. In the second place, chemical theory depends for rationalization so completely upon an intelligent conception of its many and close relations to phys-

ical laws that previous training in the measurement of the fundamental physical constants would seem to be indispensible. A close examination of the features of chemical experimentation will show the dependence of chemistry upon physical conceptions and phenomena.

In many small schools often it is found expedient to combine the science students of the last two years and teach physics and chemistry alternately. It such a case it must be remembered that the second science to be studied by a student will be measurably easier for him and can be taught in a more comprehensive way and to a more valuable end than the other. In some larger schools the same sort of combination is being made but for a different purpose. If all the science pupils of the junior and senior years are to study chemistry this year, we may be able to make several sections depending on the interests and aptitudes and needs of the students; we may be able to give to some the special preparation which they need to meet the examinations of the institutions of higher learning for which they are preparing; to a group of girls we may be able to give a course in household chemistry which would be much more profitable to them; for a group of boys going from the secondary school into industry a course in applied chemistry or industrial chemistry would be of much greater value than the stereotyped course so often found. The following year, similarly diversified courses in physics could be given. In the secondary schools of large cities this particular phase of the question is not so important, for there the work especially adapted to the future vocational needs of the students in a particular curriculum may be offered without prejudicing the value of the course to any other group.

If, in any school or in any group, it is desired to give advanced courses in either of these sciences it is not impossible to press the elementary sciences down one year or to compress those of the earlier years and thus make room for the advanced course.

For a student going to college, the content of the course in physics or chemistry is fairly definitely predetermined by the requirements of the college. For students not preparing for college the material included in the science course of study and

the method of attack may be varied to meet the needs of individual groups.

The course may be largely pure science or it may have the major emphasis laid on its applications, as in industrial chemistry. Applied science has its direct value for special groups of students. The content and method of pure science, however, is such that it has a broader field of application than has applied science and can be used in more situations than can applied science. No circumscribed utilitarian view of science teaching will carry us far toward the solution of great economic problems now before the country, and therefore an earnest plea is made for the retention of a considerable amount of pure science teaching in our secondary schools.

Because of the insistent demands and criticisms of the industrial world we now have the beginning of an attempt on the part of many of the leading secondary schools to modify their science courses in order to give better preparation to the students who expect to enter immediately upon some productive activity. Effort is being made to have students work in industrial plants in summer and then connect up during the school year the courses in science with these industries. Throughout the country a practical application of several of the sciences—chemistry, physics, botany—is being made in the rural high schools where the elements of agriculture are taught.

It has been practically admitted that the up-to-date high school, at least in the more rural sections, ought to have a one year general course in text-book agriculture for the sake of its cultural and educational value, if for no other reason. So much surely ought to be done, but no high school that means to live up to its full duty in teaching agriculture from the vocational viewpoint can spare the time in a four year course for a mere general academic study of agriculture. The logical place for such a course is in the seventh and eighth grades as a part of or parallel to the course in general science where the generalized, descriptive study of the business of agriculture and its relations to the other great world industries will provide a background for the more specialized instruction that awaits the student in the senior high school.

If agriculture should be offered in the high schools which are mainly rural; in the strictly urban high schools a corresponding trade—the dominant one in the community—should be offered in its stead. These courses scarcely come within the province of natural sciences and so have no place in this paper. Physiology is coming more and more to be taught in connection with courses in physical education and for that reason has not been considered here among the natural sciences of the curriculum.

IV. SUMMARY.

Possibly four of the points of this discussion may be summarized here.

(1) Natural science should be found in all years of the junior-senior high school, first in an informational and diagnostic role, later performing its propaedeutic function.

(2)) The science courses of study should be so organized that the subject matter is always within the range of the students' comprehension but always holds out attractive fields of exploration.

(4) The courses offered should give the student primarily from the science of one year to that of the next should be easy and natural. The arrangement proposed is general science, civic biology, general geography, physics and chemistry. This order gives the student who is forced to leave school early a valuable general survey of the scientific field.

(4) The courses offered should give the student primarily an understanding of the fundamental facts of science and in the second place some skill in the application of what they have learned to the demands of the workaday world.

Range of Information Test in General Science: Preliminary Data on Standards

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In response to numerous demands for standards of achievement in the Range of Information Test in General Science published in this journal*, the following results are reported. This amount of data is obviously entirely inadequate in quantity, but it may serve as a rough check for the present, and can be supplemented as more returns come in.

* Vol. 4, Nov., 1919, pp. 257-262.

Table I. shows the scores obtained by several groups of pupils just entering high school from the grades and before any high school science has been studied. Since only Oregon pupils are considered, it is necessary to point out that the state of Oregon has no organized nature study program, except as local authorities may provide, and that whatever science teaching is done in connection with agriculture, physiology, and hygiene, etc., is often of a very desultory and unscientific sort. For these reasons, the scores presented in Table I. would in all probability prove to be lower than those obtained in many states where the nature study idea has been better received. Any scores received in the tests as given at the end of the course in general science would need to be interpreted in the light of these initial scores.

Table I.

Showing the scores obtained in four representative city high schools of Oregon by pupils entering the high school grades. Such pupils have had no training in science other than that incidental to the grammar school curriculum and their general reading.

School	Test I			Test II		
	Median	Mean	Number	Median	Mean	Number
A	16.0	....	51	13.5	....	20
B	13.0	....	30	8.5	....	32
C	16.00	....	5	13.5	....	6
D	26.0	....	25	20.0	....	22
Combined	17.0	19.6	111	11.5	12.7	80

Table II. shows the results obtained at the end of the first semester of a two-semester course in general science for two middle western high schools. The medians are very close together, being 26.0 and 27.0. The division of the pupils of the Minnesota school into two sections on the basis of mental test suggested to the writer a similar procedure with two sections of the University High School at Eugene. Table III. shows these two groups combined as one and then classified by scores in the Stanford revision of the Binet scale. Since these pupils are all in the eighth grade, it was thought that a mental age of 14-6 would be about normal to that grade for pupils "at age" for grade. The following correlations for this group of 32 pupils were obtained:

Scores in R. of I. T. in G. S. with final grades in course 0.60 $\pm$ .076
Scores in R. of I. T. in G. S. with mental ages (Binet) 0.62 $\pm$ .073

It might be thought that a correlation of 0.60 with the final marks in the course is somewhat too low. Granting that this degree of correlation does exist, it would appear at second thought that this value is about as high as could be expected when one takes into account the multitude of factors which combine in the production of the final grade, e. g., diligence, classroom behavior, personality of the pupil, punctiliousness with assignments, neatness, spontaneity, and many others.

Table II.

Showing the scores obtained at the end of the first semester of a two-semester course in general science.

School	State	Classification	Median	Test	Number
A	Michigan	....	26.0	II	29
B	Minnesota	"Superior"	28.5	I	24
B	"	"Inferior"	24.5	I	22
B	"	Combined	27.0	I	46

Table III.

Showing the scores of 32 pupils of the University High School, Eugene, Oregon, classified according to the Binet tests. Pupils testing with a mental age 14-7 or above are classified as "Superior", those 14-6 and below as "Inferior." Results for Test I.

Classification	N	Median	Mean	Range	Number of scores below 30	Number of scores above 30
"Superior"	21	40.0	43.7	28-92	1*	20
"Inferior"	11	22.0	23.4	15-40	10	1**

* Score 28.0. ** Score 40.0.

Table IV. gives the scores at the end of a full year's work in general science for ten classes in general science, representing five different schools in different sections of the country. The exact number of pupils tested is in doubt since one school did not report on that point. The total number is probably not less than 150 and may be as large as 200. The medians vary somewhat, but in the absence of exact information as to the grades concerned in some cases, discussion of these differences will not be undertaken.

Table IV.

Showing median scores for tests given at the completion of one year of general science. Data for test I. Starred schools are junior high school grades.

School	Section	State	Grade	N	Medians
A	1	Michigan	9	32	35.2
B	1	Washington	9	11	40.0
C	1	Minnesota	9	16	37.5
D	1	Missouri*	?	?	19.0
D	2	"	?	?	23.0
D	3	"	?	?	24.0
D	4	"	?	?	25.0
D	5	"	?	?	26.0
E	1	Oregon*	8	18	30.0
E	2	"	8	15	40.0

Table V. shows the scores of fifty students in the University of Oregon chosen at random and classified according to the major subjects. The various groupings are merely those of convenience. The range of scores was 20-92. It is interesting to note that this score 92.0 was reported twice, the other case being an eighth grade boy who had just completed the first year of general science. In the case of the college student earning the highest score, the man had been graduated with an A.B. degree in chemistry and was a university instructor. In general the science majors showed a superiority over non-science majors in the ratio of about four to three.

Table V.

Showing the median scores received by fifty unselected university students, classified according to major subjects.

Major Subject	N	Median
A. Natural science (including botany, biology, physics, chemistry, zoology, natural history, and bacteriology)	15	64.0
B. Group A plus mathematics	19	65.0
C. Group B plus psychology and education	25	64.0
D. Group C plus physical education	28	61.0
E. Social sciences (including history, economics, and commerce)	3	41.0
F. Languages (including English, English literature, French, German, and prejournalism)	7	52.0
G. Arts (Music and Art)	6	57.5
H. Unknown	6	37.0
ALL COMBINED (Groups A-H)	50	56.0
ALL NON-SCIENCE MAJORS (GROUPS E-H)	22	47.0

That the college students were not entirely free from amusing and even bizarre definitions is shown by the following list of quoted replies:

Humus—a mucous secretion (zoology major)
—a bone in the arm (art major)
Anther—a butterfly's feelers (chemistry major)
—an animal (zoology major)
Fungi—sponge-like sea life (economics major)
Spore—breathing places on leaves (education major)
—fish eggs (economics major)
—part of a fish (major not stated)
Calorie—measure of extremely light weights (music major)
Tungsten—inventor of the electric light globe (zoology major). Seven of the fifty replies state that Tungsten is a man's name.
Mammal—An extinct form of animal life (economics major). Five others agree that the mammals are all extinct!
Photosynthesis—reaction of one element on another (zoology major)
—process of taking starch from sun (physical education major)
Eclipse—temporal loss of brilliancy.

It is interesting to note that the science majors do not appear to be less likely to avoid the ridiculous than do students generally although their fund of correct information is much higher as a rule.

NOTE: The writer is indebted to a number of science teachers throughout the country for cooperation in gathering these results and others not here reported. Teachers wishing to use these tests will be furnished upon request, without charge, mimeographed copies of the test lists, the only stipulation being that the results be communicated to the writer. For test materials, address Mr. Leo. H. Cossmann, University of Oregon or the writer at Stanford University, California.

Problems of Civic Science [1]

W. G. WHITMAN, State Normal School, Salem, Massachusetts.

No subject is more vitally concerned in the educational readjustment now underway in this country than is science. Nor is it in the United States alone that the World War has opened the eyes of the people to a new vision and has set new standards for us to meet. From the very beginning of the World War the inadequacy of science instruction given in the schools of Great Britain was apparent. A committee of seventeen eminent English men and women appointed to study the educational needs of Great Britain recently reported that natural science

[1] Paper given at meeting of the *New York State Science Teachers' Association*, at Rochester, N. Y., Nov. 23, 1920.

should be an essential subject in all branches of British education. They recommended the reorganization and popularization of scientific studies. They advocated the inclusion of science in the general course of education of all pupils up to sixteen years of age, particularly for those twelve to sixteen years of age and that even the girls of those years should devote thirteen percent of their school time to science. The science they recommend is that which bears on everyday life.

And so it is the world over. Science is receiving attention from educators, from statesmen and from laymen. Industrial leaders, men of big business are today pointing out the need of a liberal education with good grounding in fundamentals for our future leaders. Specialist may be developed from the all-around-educated men. This thought is particularly applicable to science study. We should not push the young pupil far in special science, but should offer him a broad, liberal science training which will give him a vision of the field of science, a grounding in the fundamentals of science, and at the same time instruct him in many of the useful applications of science in everyday life.

If science is to offer a program which interests, which grips our children and holds them, if science is to help us in training them for a better citizenship it cannot neglect the opportunities which are now open to it.

Aims of General Science.—We all approve most heartily the aims in science formulated by the N. E. A. Committee on Reorganization of Secondary Education, and which were adopted by the Science Commission appointed during the war. In brief these aims are as follows:

1. To improve the health of the individual and community.
2. To make worthy home members.
3. To produce a loyal citizenship.
4. To lead to proper use of leisure.
5. To produce ethical character.
6. To lead in vocational guidance.
7. To give one an acquaintance with fundamental science processes.

With scarcely an exception we may adopt these as worthy aims for general science in the junior high school. Today as never before we are facing city, state and national problems of so grave a character that every school subject which can con-

tribute something worth while must do so. Science is one of a few subjects which has much to offer bearing on city, state and national problems. Since science has such opportunities to help in these matters, is it not reasonable, in the general science work at least, to lay special emphasis upon that one aim dealing with citizenship?

I'm not so sure but that *good citizenship* indirectly covers all the other aims. If we strive to produce ideal citizens, we are trying to train our young people so that they will do all they can to improve the health of the community. Our ideal citizen is unquestionably a worthy home member of ethical character who uses his leisure wisely and he must have had sufficient science of a general character to be intelligent upon public matters which involve science knowledge.

Have you ever examined the topics discussed in a course in community civics? A large part of the outline suggests a course in general science. The civics deals with the city departments, their organization, etc., but the operations themselves, the explanation of how and why certain practices and processes are accomplished are science. So many of these problems deal with both science and civics that we might very properly call the course "Civic Science". Civic science can and must serve the country. It may do this by helping in the following ways:

1. Improve conditions favoring health.
2. Reduce the hazards of life.
3. Reduce waste in natural resources.
4. Create and maintain greater interest and activity in home, community and national problems.
5. Promote public appreciation of progressive programs.
6. Produce a straight-thinking generation of Americans.

It will be observed that this program of work calls for activity. A passive absorption of text book facts does not meet the present day needs. One must be alive to actual every-day life problems and the class room is merely the place for discussion of them both to give and to receive help and stimulation for further activity.

Health.—I need not give you figures to prove the lack of physical fitness of the young men of this country. The disclosures of the draft examinations are well known and let us hope not yet forgotten. It is also unfortunate that we suffer from so much sickness that is preventable. Can either of these nationwide defects be remedied by a more vigorous campaign of education in the schools? Health lessons which fix health habits are the kind needed, and they are needed while the boys and girls are forming their life habits. The health-teaching problem is perhaps the most important one in the entire school. Is the department undertaking it sufficiently supplied with all teaching aids, apparatus, models, charts, etc.—which will make the teaching more effective?

Some one may ask, "Why would you teach health in general science? Is it not hygiene, and is not hygiene taught in all our elementary schools?" Yes, good health is the main theme in hygiene and many states have laws requiring that a definite amount of school time be devoted to physiology and hygiene. A survey of towns in those states discloses the fact that the requirement is not fulfilled in many towns. A thing done by compulsion is quite often poorly done. The teaching is frequently done by one having no special qualifications for teaching hygiene. Hygiene is science and the teacher who has charge of science in a junior high school must be one who has had science training. Such a teacher can fill in a background of science to support and re-enforce the teaching of hygiene. In a recent survey a large majority of the superintendents in Massachusetts reported in favor of having the hygiene included in the general science course rather than given separately.

This large national good health problem involves hundreds of smaller ones. First of these are the personal health problems of the people, then of the family, then of health in the community. Many problems starting with the home, reach out into the community so that one scarcely knows where the home problem ends or where the community problem begins and it is unnecessary

to know. Let us list a few of the more important problems.

1. How to secure pure, fresh air.
2. How to secure pure water.
3. How to secure pure foods.
4. How to secure cleanliness of body, of home, of town or city.
5. The proper methods of removal of wastes.
6. Proper shelter and clothing.
7. Correct personal health habits.
8. How to keep the body in vigorous "fighting trim."

There are 600,000 beds in hospitals in this country whose yearly maintenance costs a quarter of a billion of dollars. We are glad to have this provision for the sick. But the pity is that there is so much sickness. Let us not go into health bankruptcy and become a national hospital with the bulk of our population invalids or half-fit men and women. Health is an asset to every individual. Every well, able-bodied man and woman is an asset to his community and all well citizens are assets of the nation.

Hazards of life.—Next to sickness, accidents take the most lives of citizens. Carelessness accounts for nine out of every ten of these. Accidents are, then, nine-tenths preventable. It is largely due to lack of education that people are so careless. Carefulness about chance taking must be given more attention in education. Industrial accidents claim the largest toll of lives. The 7,000,000 automobiles now in use in this country are doing their share in decreasing our population. The automobile and traffic problems in our public thoroughfares are serious problems, which are worthy of serious consideration in school. The railroads, with their 200,000 grade crossings, kill thousands a year, while our 500,000 yearly fires take thousands more. Let us not stop with teaching the principles underlying the automobile. The science problem may be "How does the automobile go?" But we have a civic duty to perform when we discuss the automobile. This may be stated as a problem—"How can the automobile be operated safely?" The discussion may well suggest more stringent laws, with serever penalties for careless drivers. It must emphasis the need of "safe and sane" driving We must not neglect consideration of careless pedestrians, and we shall surely include a plea for cooperation with traffic officers.

Waste of Natural Resources.—Picture the East in Colonial days, with its rugged stand of fine forest timber. Wood for

fuel and lumber for building were but the by-products of clearing the soil for crops. The forest problem as it existed then was how to get rid of the forests to secure land to cultivate. Forests were also a barrier, holding the early settlers east of the Appalachians for two hundred years. Contrast the picture of those primeval forests with the picture of the East of today! In place of that group of sturdy oaks, we find a busy city; in place of those maples and birches, we find pastures; and in place of those towering firs and pines, we find scrubby brush or waste land, and on steep hillsides, even the land is disappearing, being washed away by every rain that comes. Today's problems are to find substitutes for the fast disappearing wood, to find ways of conserving our present forest, and to devise means of bringing back some of the old-time forest area by reforesting the waste lands.

We cannot begin too early to impress our boys and girls with the gravity of these problems. Many boys and girls are willing to spend a portion of their time in reforesting a part of the barren farm land in their vicinity. If this practice could be made more general, the result might reach proportions of national importance.

Some results of a shortage of coal still linger in our memory. We are told that the supply in the earth is limited, hence for the benefit of future generations it is our duty to conserve it. When we glance at the ashes removed from our houses and carried to the dump, we often wonder if these dumps will not some day be profitably worked as sources of coal. It is no rare case to find that 20% of the coal put into the furnace is unburned and wasted. Poor control of the fire may result in a 10% loss through incomplete combustion of the coal gases. Defective insulation or lack of insulation and unnecessary loss of heat through hot gases escaping up the chimney may take 25% of the coal's energy, and so problem after problem comes for solution, while the rank and file, the average citizen of today, little cares or heeds. It is the privilege of our science to make these problems real problems, whose partial solution even will be at least a start in the right direction.

Former Secretary Lane of the Department of the Interior has said that there are two and one-half million domestic natural gas consumers who waste over 80% of the gas received! And there is little doubt but that in the average home using artificial gas,

one cubic foot of gas could easily be made to do the work now done by two cubic feet. Mr. J. Richard Lunt of the English High School, Boston, has done some interesting work in this connection in his general science class. Out of 648 boys, 542 reported that gas was used in their homes. Of these, 316 used gas ranges, 287 used open burners for illumination, 182 used some open and some mantle burners, while only 73 used all mantle burners. One month after the study of illuminating gas was undertaken they reported 712 mantle burners had been substituted for the open burners 85 gas ranges had been adjusted; 336 reported that gas bills were reduced 5% to 60%; the total reduction reported for one month was $128.

One great national waste is that of water power. A well informed public is needed to carry through important government projects of this character. There is also great waste of water in our various domestic and industrial processes. A section of the city of Boston was recently investigated to find water waste. In a district using six million gallons per day, there was lost, by leakage principally, nine hundred thousand gallons per day. Without doubt, a proportionate loss exists in other sections of Boston and also in other cities. For every five gallons used nearly one gallon is wasted. Every sixth stroke of the pumping engines is a waste stroke. Out of every six tons of coal burned to run the engines, one ton ought to be saved. Can boys and girls help in this conservation? Let them survey their homes for leaking faucets. Let them find out by tests how much water is wasted in their homes. Encourage them to apply such remedies as they can and to report conditions at a later date.

These four natural resource waste problems are but examples. There are many others. Is it not worth while to bring these matters before our pupils and to interest them in every way possible in some of these very important national problems?

Home and Community Problems.—Whether or not it is true, as stated by some authorities, that one-third of Americans are underfed, the food problems are ever present and real problems. They are problems that touch a vital spot in the home, but which cannot be separated from the communal and national problems. We must teach in our science not merely why we eat but we must tell what foods and what quantities are needed, and also indicate what variations to make for different conditions. Every

citizen should know in general what the city, the state and the national government require of dealers and manufacturers under the Pure Food and Drug Act and he should also take an active interest to see if the requirements of the law enforced in his community. Without a watchful public great harm can be done in addition to the fact that cheap substitutes will bring the high prices of genuine foods.

In 1818, the fire loss in the United States was $300,000,000. In 1919 it was $325,000,000. We have four to five times the fire loss per capita of any country on the face of the globe. Week after week, the parents of our pupils read of someone who used kerosene to start the fire and was burned to death, and yet there is always some pupil, when asked how to build a fire, that will insist that kerosene is safe because it has always been used in his home without harm. It is not only willful neglect but carelessness from ignorance in dealing with fire that the schools must teach, and the parents must be taught through the children as far as possible. This must be done by a strenuous campaign if our national fire losses are ever to be reduced to a reasonable figure. This is one of the big problems which the science course must assume if it is to be a vital factor in real life. Not only are we to teach carefulness in matters of fire, but we must make our citizens intelligent about fire-fighting, particularly the value of small home extinguishers which, if used, would doubtless make it unnecessary to call on the fire department in fifty per cent of the home fires.

The problem of proper arrangement and use of lights in the home is an important one. The eye, one of the most delicate organs of the human body, deserves more consideration than is commonly given it. A survey of the lighting conditions where some of your pupils study will be a revelation to you. You will wish to start a campaign for better home lighting at once. Not only in the home is lighting a problem, but it is a bigger problem for the community, and every citizen should take active and intelligent interest in it. You know the merchant who wishes to attract a fine class of customers to his store will have modern lighting and fixtures that will not offend a refined taste. In the same way, good lighting and artistic lighting fixtures are a big asset to the community.

In these days of high cost of labor, labor saving devices are rapidly increasing. Efficiency in factories has for many years

been increased by their use. Many problems of home efficiency discussed by pupils may well stimulate the parents to better and easier methods, to additions to the home equipment, and to advantageous rearrangements in the house. Likewise in municipal housekeeping it is often economy to spend money for a machine which will do better work and more efficient work than what is now done. Picture for yourself a community with modern street cleaning equipment and with motor fire apparatus and another community with only the broom and shovel street cleaner, or perhaps no street cleaner at all, and with the horse drawn or man drawn fire apparatus. Problems in these matters are interesting. They involve many science questions and show the pupil that science is after all a part of real life.

Science problems relating to communication start in the home where the voice and the ear are about the only devices used. But they lead through the telephone and telegraph to the most distant parts of our country, or through cable and wireless to the ends of the world or beyond—for who can say that our messages do not reach Mars and other planets, even though no one receives them? Let us teach appreciation, too, of the wonderful systems which produce written communications, books and papers, and the wonderfully efficient mail service which brings these and letters to our doors.

Transportation problems I suppose have presented themselves to dwellers of the earth ever since man became restless enough to desire to move from one place to another. Many complex problems were worked out by early peoples on the earth; but the last one hundred years has solved far more and greater problems than all the ages preceding. One hundred years ago there were no steamboats or locomotives. Fifty years ago there were no electric cars or electric locomotives. Twenty-five years ago there were no automobiles. Ten years ago there were no passenger or mail-carrying airplanes. Roads, bridges and trolleys have been developed at a cost of billions of dollars. Millions and millions of people are daily dependent upon train, trolley and auto to reach their places of business. Children are eager to know something about how these devices have been evolved and how they work. Other public utilities besides those included under communication and transportation which touch home life as well as the community are the gas and electric plants. The

products of these are almost household necessities in our larger communities.

The life program of an individual, consisting of all work and all serious thought, is not well balanced any more than is that program from which all work and serious thought are lacking. People of all ages should work and they should likewise have their recreation. There should be provision on the home grounds for games. There should be indoor games and other forms of recreation for all members of the family. Cities must consider well the problems of recreation and provide parks, playgrounds, public baths and concerts.

Is there science in recreation? What about the curving of a baseball? The home run? The "split ball" in croquet? The use of the bow and arrow? The use of rifle sights? The operation of mechanical toys? Tacking in sailing? The flying of kites? The model aeroplane? The gas filled soap bubbles? How one swims? The use of the camera? Taking and making pictures? The working of the phonograph? The production of mechanical sounds? The principles of motion pictures? The operations required in running an automobile? And a thousand other things which are involved in our varied forms of recreation? Science, perhaps more than any other factor, has been applied to provide recreation. An important place in the general science course ought to be given to the science in recreations, for knowing "how" and "why" gives one satisfaction. Enjoyable recreation leads to contentment and a contented people has few mischief makers.

All these civic problems, yes and many more touching the home and community, involve in their understanding a solution of many facts and processes from the field of science, and I ask you whether it is not the province of general science to interest the future citizens in these problems as far as his capacity at the time permits.

Is it better to teach how falling bodies are accelerated in speed by gravity and the rate for rising bodies is retarded in speed by gravity, with all the various formulas which fit different cases; to teach mass and weight as abstract units; and to teach refined methods of weighing where the error of ordinary weighing is negligible for the purpose at hand; or to teach more briefly what gravity does and have more time to study weight as we encounter it in everyday

life; the principles of different types of balances; how fraudulent dealers try to trick us and how the city, state and national government try to protect the citizens against fraudulent weights? What per cent of purchasers ever take thought, not to mention taking the active means of finding out whether they are getting the quantity of produce paid for? Without knowledge that fraud is quite often attempted, without interest in securing just measures, fraud becomes more prevalent because of the lack of public activity.

Civic Activity.—People who do not stand up for their own rights will suffer. A public active in all civic problems will have a far better city to show for this activity than one in which the public is ignorant and indifferent in public matters. Perhaps you may have read of the western city which placed in large letters over all roads entering the city "— a 100% City" so that all travelers who could read might know that they were entering a city which was wide-awake and working for one thing.

One traveler, much impressed as he read, hailed a fifteen year old youth by the road-side.

"See here, my son, I have just read your sign a 100% city and then I go bumpety bump over your worn out roads. You can't score 100% on roads, can you?"

"No sir."

"And I enjoy scenery but your most picturesque spots are marred by ugly bill boards. You can't score 100% for attractiveness, can you?"

"No sir."

"I do see the houses and grounds are well kept, streets are clean, electric wires are obscured and the trees are well cared for, but a place can't brag of being a 100% city unless it can count 100% in all these various items."

"Well," replied the boy, "You don't understand that sign. We know we can't score 100% now but *our ideal* is a 100% city and we are trying to make it so. We haven't money now to give us 100% roads. It requires state legislation to get rid of the bill boards. But say, Mister, if you had seen us when that sign was first put up and then compared us today with that, well, I guess you'd say we have come up 500% from what we were then. We keep changing out ideal and we score harder, so I suppose the next time you come this way, we will still be working for that 100%."

Where Should Civic Science be Taught?—The problems of civic science suggested touch home life, community life, and national live. These three divisions make natural boundaries within which to organize our science work. The division of the work into three groups is convenient for the junior high school. I would suggest for the seventh grade, *Home Science,* that is, make the home the unit about which the science is organized. This would be followed in the eighth grade by *Community Science,* in which the community is made the organizing unit. The ninth grade or first year of the high school might consider the science work which is done by the government and the science which underlies our basis national industries. It might also introduce the pupil to the special sciences. Because of the important place the basis industries would occupy in this course, it might be called, *Industrial Science.*

Such a program of science can be offered without interfering with other essential studies. It will strengthen the allied courses of geography, hygiene, and civics, if given, and offers a splendid field for correlation with mathematics, English and manual arts

Teaching Aids.—A very helpful device for finding both the defects and the good features of both home and community is the score card. Let the pupils score themselves on personal health habits, the home on fire hazards, the community on the safeguarding of life and property of its citizens, and on a dozen other things. Let the defects, disclosed by the scoring, be the subjects for class discussion to suggest means of improvement or remedy. Encourage pupils in many instances to become the active agent working for improvement. This will naturally lead us into project work and the more real projects we can get under way, the more worth while will our teaching be. Many teachers have found that the Science Club, in which pupils take full charge of the program and carry it through, is particularly helpful in stimulating pupils to greater activity in all lines of project work.

Straight-Thinking Americans.—As a people we are not yet quite free from superstition, nor are we entirely free from many popular fallacies. Straight thinking and information are the two essentials which alone can remove these from us. Some believe men can locate hidden streams of water with the crotched witch-hazel twig. Some others plant their gardens only at the full of the moon. Others have fear of some dreadful event which

will follow their seeing a black cat in their path, or seeing the new moon over their left shoulder. There are hundreds of other equally absurd notions which are firmly believed by thousands and thousands of our people. Some people who have an abundance of science facts are unable to think straight or to reason logically, and so waste their time in trying to make perpetual motion machines. Many people are unable to reason from cause to effect, nor do they draw practical conclusions from every day evidences. On the other hand, there are people who draw conclusions from insufficient evidences. One of the promises of experimental science is that it will materially help in increasing one's power to reason logically and to draw proper conclusions from the evidence at hand.

The application of scientific method in every day life is somewhat as follows: Some question arises. We know little about it but we may venture an opinion as a "guess." We separate what we do know from what we guess. This guess matter or the uncertain knowledge becomes a problem for investigation. We go to authoritative sources—books, people, or to the real objects in question. We may resort to experiments in which we put the question to nature and get the answer directly from nature. From these accumulated data we draw our conclusion. Then we test this conclusion by a process of verification, which may or may not be done by experiment. This process of solving a science problem or the scientific method may become a habit of daily experience; and when it does, it eliminates fallacies and superstitions. Some people are controlled by fallacies regarding government. Without ability to reason through to an ultimate conclusion, they unwittingly deceive themselves. There is need of diminishing the menace of these ideas by increasing the number of straight-thinking Americans. To this end our science studies should all include a certain amount of individual experimental work, where the pupil may develop the habit of working out conclusions warranted by evidence he has observed, and to show the absurdity of jumping at conclusions without due consideration.

Two or three years of science work of the type suggested ought to guide the pupil in the right course in civic matters and aid him in forming habits which will make him a worthy citizen of the nation.

Some Experiments With Flame

CHARLES H. STONE, English High School, Boston.

After a study of the air and of its contained oxygen with regard to combustion, some time may profitably be spent with the class in a study of flame. The following simple experiments will show most of the important facts which should be brought out with regard to flame. Some of these experiments should be done by the teacher only, as there is some danger in working with such inflammable materials as ether and alcohol when put into the hands of inexperienced or unskillful students.

I. What substances burn with a flame?

a. Ignite a fine iron wire and thrust it quickly into a jar of oxygen. Note whether the wire burns with flame or not.

b. Arrange apparatus as shown in fig. 1. Pass a slow steady stream of air through a little alcohol in the tube as shown. Bring a flame to the mouth of the tube. Where does the flame appear? Does it run down the tube to the liquid alcohol Does the liquid itself burn?

c. Remove the air tube. Bring a flame to the mouth of tube containing the alcohol. Is there a flame? Boil the alcohol gently and again bring a flame to mouth of tube. Is there now a flame?

d. Ignite the gas at a Bunsen burner. Is there a flame?

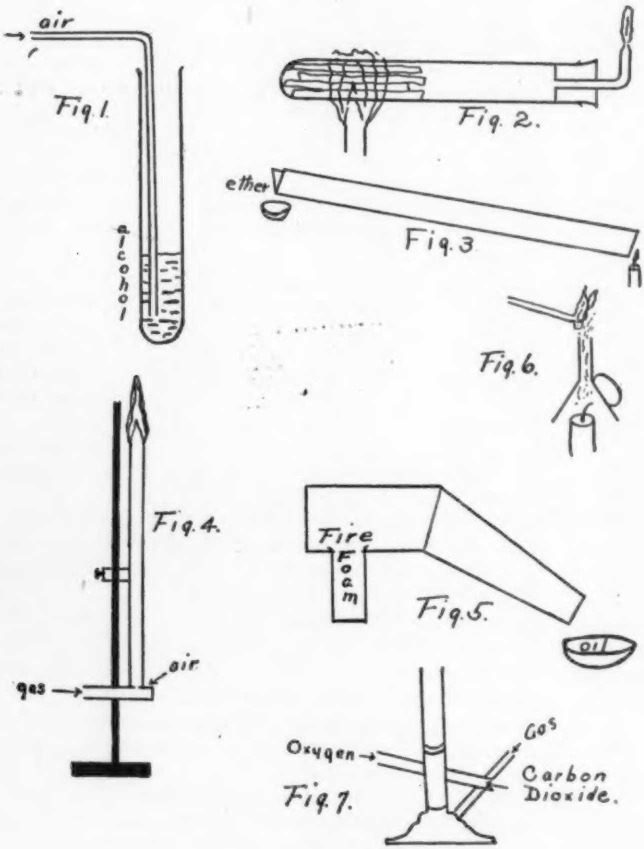
The above experiments show that substances burn with a flame only when in the gaseous condition. If a substance cannot be vaporized it does not burn with a flame.

e. Ignite a splint of wood. Is there a flame?

f. Put into a dry test-tube some wood splints as shown in fig. 2. Arrange stopper and jet as shown. Heat the wood strongly and bring a flame to tip of jet. Is there a flame? Why? Continue until the wood is completely changed to charcoal.

g. Remove some of the charcoal. Will it burn with a flame? Why?

h. Ignite a candle and after it is burning well, extinguish the flame. Bring a lighted match near the tip of wick but not touching it. Does the candle light? Why? (By using a small metal funnel inverted over the candle, the distance between match and wick may be much increased, but the funnel must previously be heated to avoid cooling the rising gas.) Fig. 6.



SOME FLAME EXPERIMENTS

II. Conduction of flame.

The last experiment above shows how a flame may travel along a gas-laden atmosphere. The following illustrate this further.

a. Arrange apparatus as shown in fig. 3. The V-shaped trough may be made from zinc or galvanized iron and should be about three feet long. A small dish containing ether is placed under the upper end of the trough and a lighted candle under the lower end. One or two cc of ether are then poured into the upper end of the trough. The ether rapidly vaporizes and its heavy vapor flows down the trough. What finally happens? (Do not add too much ether to the trough; *liquid* ether should not flow out at the lower end of trough.)

b. When a gas laden atmosphere is confined in a closed space and ignited, an explosion results. The flame travels rapidly through the mixed gases. A (carbon disulphide) tin can is tightly corked and a ¼ inch hole made in the center of the bottom. Stand the can on the ring of a ring stand, allow hydrogen from a generator to flow in at the bottom of the can; let the gases have time to mix thoroughly (one minute) and then bring a flame to the opening in the bottom of the can. What happens? Why?

c. The flame of a Bunsen burner often "strikes back". The following apparatus may be used to explain "striking back". See fig. 4. Let illuminating gas flow in and ignite it at the top of the tube. Gradually raise the tube so that air is admitted at the bottom. When the tube has been raised to the proper height, the flame "strikes back". Why does it do this?

III. To what is the luminosity of flames due?

a. Into the colorless flame of a Bunsen burner sprinkle a little powdered charcoal, or better, blow it gently in through a bent glass elbow with one long arm. Does the flame now give more light?

b. Repeat the experiment, using powdered iron, magnesium, and other finely divided material. Note if there is any difference in the color of the light produced.

Fine particles of any substance heated to incandescence in a flame cause light to be given off.

IV. To what is the color of a flame due?

The previous experiment called attention to some differences in color. The following will illustrate this further.

a. Dip a clean platinum wire in a strong solution of lithium chloride and hold the wire in the colorless flame of the Bunsen burner.

b. Repeat, using solutions of barium chloride, sodium chloride, potassium chloride (view through blue glass), strontium chloride.

V. The structure of a flame.

a. Hold a thick piece of cardboard across the colorless Bunsen flame at right angles to its axis and cutting through the green cone. After a short time remove card and examine. Hold another card across the flame above tip of green cone. Compare results.

b. Suspend a match by means of a pin stuck through it so that the match hangs inside the burner tube with the head exactly in the center and about 1/4 inch above top of tube. Ignite the gas.

c. Fit a piece of fine wire gauze over the top of a small glass funnel. Stand the stem of the funnel in the tube of the Bunsen burner. Put a little gunpowder in the center of the wire gauze. Ignite the gas. Does the gunpowder burn? Why? Gradually turn down the flame. What finally happens? Why?

d. Insert one end of a straight piece of glass tubing 6 inches long into the green cone of the Bunsen, the tube sloping upward at an angle of 45 degrees. Bring a flame to outer end of tube. Does the green cone of the Bunsen flame consist of burning or unburned gas?

VI. Extinguishing flames.

a. Remove or shut off the supply of oxygen. Ignite in a small dish 5 cc ether or alcohol. When burning briskly, cover the dish with a thick sheet of asbestos board or a double thickness of cardboard. Cool the burning substance below its kindling point.

b. Make a small coil of bare copper wire by winding a dozen turns around a piece of 6 mm glass tubing Let one end of the wire extend for a handle. Ignite a candle and lower the coil over the flame so that flame is inside coil. What happens. (Davy safety lamp.) Heat the coil in a flame and again lower it over a candle flame as before. What happens? How do you explain the difference?

c. Introduce a non-supporter of combustion. Attach a small candle to a small square of cardbord and stand the lighted candle in a tumbler or tall jar. Pour in carbon dioxide from another jar, or pass it in from a generator.

d. The use of Fire Foam. Many oil fires are difficult to extinguish since water is not effective and the heat

of the flame creates a current of air which carries upward with it non-supporting gases which may be used. Prepare two solutions as follows: No. 1, 10 grams aluminium sulphate, 1 gram glue, and 100 cc water. No. 2, 10 grams sodium bicarbonate, 1 gram glue and 100 cc water. Construct apparatus as shown in fig. 5. (The writer used two chalk boxes fastened together at an angle. In the bottom of the first box an opening was made large enough to admit and support a 250 cc beaker.) Oil is placed in the jar or large evaporating dish beneath the lower end of the chute. Ignite the oil and when burning vigorously, pour the two prepared solutions into the large beaker.

VII. How does diluting a gas affect the flame? (Fig. 7.)

a. Screw two short pieces of brass tubing into the holes of a Bunsen burner. Connect one of these to an oxygen supply; connect the other to a carbon dioxide generator. Ignite the gas which burns with a yellow flame since it is has no air supply. Now admit oxygen from the holder. What happens? Shut off the oxygen and admit carbon dioxide. What happens? How do you explain these results?

Simple Food Tests

Arthur W. Taylor, High School, Salem, Mass.

It seems to the writer that in these days of food conservation it is a very easy matter to interest and instruct the High School freshman, or pupil in the upper section of the Junior High in foods, their testing, and value to the individual.

With the aid of the many texts and outlines, the Government bulletins and colored food charts, it is a most inspiring project to bring a class up through the simple compounds of carbon and on to the complex foods. The gas that is burned at home for heat and light, the gasoline used for cleaning, the paraffin that is put over jars as a preservative, furnish a base for future action that is firm. Then the starches, sugars, proteins, fats, acids, and some by-products, not commonly used as food, will complete a period of vital interest.

In the space alloted here, it is manifestly impossible to give in detail all the tests that have proved worth while, but I trust that the reader may see the plan of work so clearly that it will be possible to amplify such tests as seem adaptable to a given

situation. The pupil should bring the material from home, as in that way interest in the result will be at once associated with life outside the school. Many tests can be done equally well in the home.

A. CARBON. Burn in suitable holders, a small amount of sugar, starch, a piece of meat, a portion of bread, wood, cotton, or wool, until there is only a charcoal left. This will show a very common element, carbon, as the foundation of many things in life. With the Welsbach mantle, or the gas stove or laboratory burner so arranged that the air supply is cut nearly off, carbon is again evident in the black deposit. (Hydrogen and oxygen can be shown at this time by collecting the moisture *from* the burning substance in a tube, and explaining its origin. The action of a lighted paraffin candle when *slowly* lowered and raised in a bottle of chlorine, is sure to get the pupils' attention, because it breaks up and gives off carbon as a dense smoke, while the hydrogen combines with the chlorine producing what I have called the "spirit of the candle".

B. STARCH. Make up a weak mixture of oatmeal, rice, cornstarch, potato, carrot, parsnip, or other available starchy food in cold water, bring slowly to a boil, and add a little tincture of iodine. The characteristic iodine blue will show starch in all. Test again, using cane sugar, or white of egg and note the absence of starch.

C. REDUCING SUGARS. Boil a small portion of Karo, raisin, orange juice, currant, bread crust, in water, and add hot Fehling's solution. The presence of a reducing sugar is evident from the color which appears, varying under the conditions of the experiment from an orange yellow to a dark red. A similar test with starch or cane sugar will point the differences.

Another exercise at this point on the action of acids on starches and sugars will show how one may be changed into the other. For instance, if a few cubic centimeters of a dilute mineral acid be added to a starch paste and slowly boiled, it will hydrolize the starch to a sugar that will so test. Similarly, granulated sugar can be reduced by an acid. *But* more enlightening still, if a cornstarch paste be made, warmed a little, and then after the addition of some fresh saliva be placed in a hot water bath and heated for a half

hour, it will test for a reducing *sugar*. This will, to my mind, furnish a climax.

D. PROTEINS. Protein in its many forms is so important in the diet that many types are easily obtainable. Let the pupil bring in several, for illustration; milk, cheese, egg, split peas, lean meat, fish, oysters, clams, corn meal, oatmeal, puffed wheat, macaroni. Take a small portion in a test tube or other container, add 5-10 c. c. of water, an equal amount of dilute nitric acid, and bring carefully to a boil. The characteristic yellow, intensified by ammonia will prove the material to be protein. A repetition using wool, feathers, quills, will widen the field of protein compounds and lay a foundation for the study of textiles.

When the protein itself is yellow a very satisfactory test is made by adding to the liquid decanted from the boiled sample a little sodium hydroxide, and then drop by drop some copper sulphate. The "bi-uret" purple will prove the quest, be it positive or negative.

If the sample be burned it will give off the peculiar odor of smoldering feathers. Or again if mixed with dry calcium hydroxide and warmed it will smell of ammonia.

E. The grease spot on paper or cloth made by rubbing any fatty tissue or oily meal into the fabric is an instructive test, especially when used in conjunction with a solubility test in ether, gasoline, benzole, or some other solvent. Halphen's reagent test on a known cottonseed oil sample, followed by an application to some table oil, lard substitute, or oleomargarine so widely sold today, and against which there is so much unwarranted prejudice, will show the pupil that the substitute which he may have eaten for some time is of the same composition as the one which he has been instructed to reject. The various other oils which may be added can be tested for by other means and the exact nature of the material known.

The foam or "spoon" test for butter and oleos is equally easy and instructive. Put a small portion of the sample in a spoon and heat slowly. The butter will melt with little noise and produce much foam, while the oleo or other substitute will crackle and give no foam.

F. MISCELLANEOUS. If an egg is placed in a salt solution made by dissolving about two ounces of salt to a pint of water,

it will sink, if fresh; just float immersed if a few days old, and float well out of water if stale. A fresh egg upon shaking will give no sound indicating a moving substance; a stale egg will shake a little, while a spoiled egg will rattle. The candle method is equally easy, but will not be given here in detail.

The above tests may be amplified by reference to any of the books now crowding to the front for recognition, and the pupil's knowledge of home conditions given such a firm foundation that instead of eating carelessly of what is offered he will be able to make an intelligent choice, and diagnose his need for himself. And when that is done, the work of the teacher is done as well, for the seed of independent thought has struck root, and like a plant, will respond to the stimuli of life in a natural manner. Then and only then, will sickness and disease stalk no more, invited in by ignorance and superstition.

A General Science Demonstration Desk with Filing System For Storing Apparatus

Chas. W. Finley and Earl R. Glenn, The Lincoln School of Teachers College, Columbia University, New York.

General science has now become an established course in American high schools,[1] and in a recent report is recommended as a first-year course in those of Great Britain.[2] It frequently happens that because of the crowded conditions in schools this work is taught in rooms poorly fitted for science, in which there is inadequate demonstration materials or storage space for these materials. In many high schools it is the practice to spend most of the money allotted to science equipment on the courses in the upper years, with the result that there is a lack of materials and apparatus in the beginning science courses. When we consider that 150 first-year pupils out of each 316 do not reach the third year[3] it is evident that about half of the high school population

1 Report of N. E. A. Commission on Reorganization of Secondary School Science, 1920, U. S. Bureau of Education.

2 Natural Science in Education. Report of the Committee on the Position of Natural Science in the educational system of Great Britain, 1918.

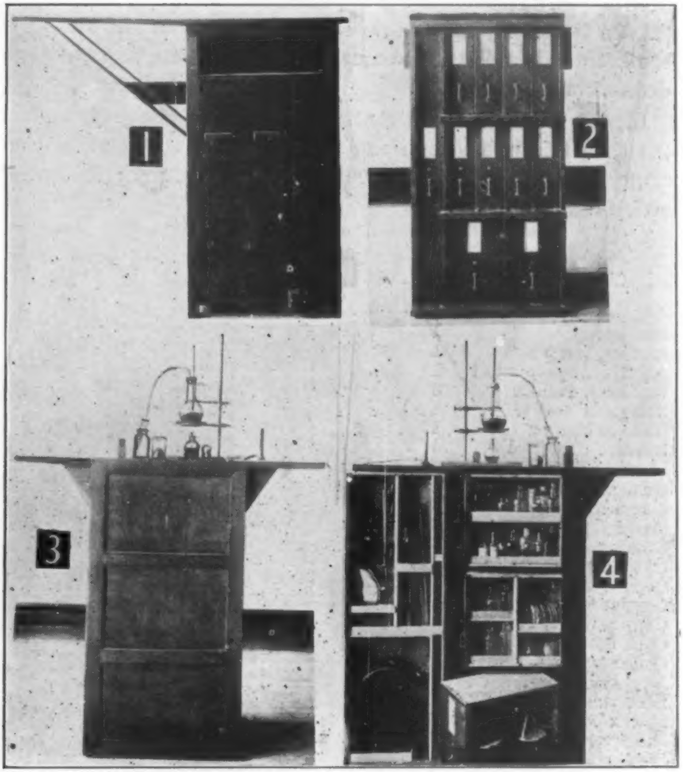
3 Bonner, H. R., Statistics of State School Systems 1917-18. Bulletin, 1920, No. 11. Page 31.

is taught in classes inadequately equipped with science materials and apparatus. There seems to be a definite movement in general science teaching to make more use of demonstrations. The knowledge that many teachers in general science have the work added to an already crowded day and that the teaching is often done in rooms poorly equipped for it has prompted the writers to record a solution to the problem that has resulted in overcoming some of these difficulties and in the saving of much time.

Because of crowded conditions in our school it became imperative to teach a course in general science in a room devoid of gas and flowing water and in which there was no available storage space. For a few weeks it was the daily duty of one of the writers to return borrowed apparatus and materials and procure a new supply from a laboratory two stories removed from the room in which the general science was being taught. This routine became a source of much wasted time and continual annoyance to both teachers concerned. It was decided to see whether some plan might not be devised to remedy this difficulty. A list of pieces of apparatus and of materials needed for the year's work was made out and the writers set to work to devise and construct a desk which would serve at the same time as a storage place for the apparatus and a demonstration desk for class use.

The first demonstration case was made by us in our own industrial arts shop. The joints were somewhat crude and it is very probable that the desk would not have been accepted as an addition to the furniture in that shop. It served our purpose, however, as in it we were able to store the apparatus and materials needed for the year's work. As is seen in the illustration (Fig. 1) it was equipped with a double top, so hinged that it could be opened, and braced against the side, making a space for demonstration work double the size of that of the regular top.

In storing the apparatus and materials needed for the work, all the available space in the desk was taken. This crowded condition made the case somewhat unwieldy and cumbersome. It will be noted that access to the space for storing the longer pieces of apparatus as yard sticks, meter sticks, glass and metal tubing was obtained through a door. It proved to be somewhat annoying to get anything from the back part of this narrow



GENERAL SCIENCE DEMONSTRATION TABLE

space. So many small pieces were stored in the one drawer that constant effort was required to keep things in order.

A commercial company[4] has devised a vertical filing section which may be pulled the entire length from its case making the entire contents easily available. The writers designed a desk patterned after the original one made by themselves but modified in such a way as to make use of the vertical filing system. In this new desk the contents of each section may be listed on the

[4] Schwartz Sectional System, Indianapolis, Indiana.

index plate as shown in figure two. We have found this index system easily applied to the apparatus lists given in the various science texts. By appending drawer numbers to the articles in the list one is able to save much time in locating apparatus for demonstrations (Fig. 3).

Figure four shows the contents of some of the sections. At the time this photograph was taken, two of the sections were empty and in the remainder there were stored the following articles:

A. GENERAL APPARATUS.

Article	Quantity	
Air pump	1	
Alcohol lamp	1	
Aquarium jar, small	1	
Balloons, rubber	6	
Bell jars	1	
Bunsen burner	1	
Burette clamps 4	4	
Electric buzzers	2	
Can, metal, one pint	1	
Candles	3	
Carbon rods	6	
Clamps	6	
Compass, magnetic	4	
Copper sheet	1	sq. ft.
Copper wire No. 18	1	lb.
Copper wire, No. 24	1	lb.
Cork borer,	1	set
Cork stoppers, assorted	1	doz.
Dry cells	5	
Electric bells	2	
Filter paper	500	sheets
Flower pots	12	
Hammer	1	
Hand lens	2	
Electrolysis apparatus	1	
Iron pans	12	
Iron wire, No. 20	1	lb.
Locomotive model	1	
Magnets, bar	4	
Magnets, U-form	4	
Matches, safety	5	boxes
Medicine dropper	1	
Meter stick	2	
Mercury	2	lbs.
Microscope slides and covers	50	
Motor, St. Louis form	1	
Mortar and pestle	1	
Needles	3	doz.
Osmometer	1	
Pinchcock	6	
Pliers	1	
Pulleys, single	2	
Pulleys, double	2	
Push buttons	6	
Ring stands	3	
Rubber sheet	1	sq. ft.
Rubber bands, assorted	1	box
Rubber friction tape	1	roll
Rubber stoppers, assorted	2	lbs.
Rubber tubing, gum	10	ft.
Rubber tubing, heavy wall	10	ft.
Rulers,	2	
Scales, Cenco	1	
Screw driver	1	
Spring balances	2	
Switches, battery	2	
Test-tube brush	1	
Test-tube holder	1	
Test-tube stand	1	
Thermometers	2	
Tripod, iron	1	
Tweezers	1	
Weights, metric	1	set
Wire gauze	2	
Y-tubes	2	

B. GLASSWARE.

Beakers, 100 cc	3	
Beakers, 250 cc	3	
Bottles, wide-mouth	12	
Calcium chloride tubes	6	
Cylinder, 1 liter	1	
Dishes, crystallizing	3	
Flasks, 500 cc	2	
Funnels	3	
Glass tubing, assorted	5	lbs.
Glass plates	12	
Graduates, 500 cc	1	
Petri dishes	6	
Test-tubes, assorted	4	doz.
Thistle tubes	2	

C. CHEMICALS.

Article	Quantity	Article	Quantity
Alcohol, denatured	1 pint	Iron filings	1 lb.
Ammonium hydroxid	1 lb.	Lime water	8 oz.
Beeswax	8 oz.	Marble	1 lb.
Charcoal	1 lb.	Nitric acid	1 lb.
Fehling's solutions	4 oz. each	Paraffin	1 lb.
Hydrochloric acid	1 lb.	Potassium nitrate	8 oz.
Iodine solution	100 cc.	Sodium hydroxide	1 lb.
		Zinc	1 lb.

The firm mentioned above is now listing the case as a "Chemistry Desk." We are anxious however, to have it clearly understood that it was not designed as a chemistry desk but as one for general science materials for use especially in schools or rooms not well equipped for that type of work, and that our only interest in the desk is the hope that it may be of help to other teachers of general science.

The Present Day Status And The Future of Public School Physiology

By DR. N. M. GRIER,
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The present day trend of our educational policy in some quarters seems to be towards limiting required instruction in public school physiology and hygiene (commonly termed physiology) to the grades. To the writer it seems that justification can be found for this only if the reasons commonly assigned are found to outweigh such benefits obtainable from the teaching of this subject in an up-to-date manner and in its broader aspects as along lines similar to those hereafter indicated.

One reason for this partially accomplished change seems peculiarly inherent in the adolescent—that after 16 years at the latest any biological science (including physiology and hygiene) does not appeal to the great majority of them. Their aims at such a time seem to be toward those subjects of the school curriculum which will give their innate individuality its greatest expression in the shortest time. In a further effort to understand the viewpoint of the adolescent in this matter, we may state that it appears harder for them to estimate the worth of this subject in material terms than is the case for example in other sciences such as physics or chemistry. Further as we supply no vital motive for their additional grounding in the applied human science, no necessity for additional instruction strikes them during this period of nimble exuberance. So far as their personal physical welfare is concerned, they reason that the more important part may

*For suggestions along these lines see papers by the writer: "*Historical vs. Vocational Aspects of Public School Physiology,*" Atlantic Educational Journal, Sept. 1917; "*Vitalizing Physiology,*" School Science, Vol. 16, 1916; "*Range of Information Test in Biology,*" Journal of Educational Psychology, Vol. 9, No. 4, April 1918.

be left to the physician, who as we know, often begins his race with disease on a handicap. Even with this we might have greater faith in the judgment of our boys and girls in this situation if physicians were by any means abundant, or if the time of those available was efficiently used by the public. The latter, however, still regards the physician as a healer rather than a preventer of sickness, and the sentiment that all should be examined by the physician or dentist twice a year with the latter point in view, is far from crystallization. If, as the writer hopes later to show, the physical and mental health of our country presents us questions really as vital as the issues for which we fought the late war, we shall scarcely withhold involuntary mobilization measures in a war for better health any more than we did then, and such a move would be in full accord with a sensible, constructive and disciplinary view what Education may be said to consist.

For the fullest comprehension of the physical and chemical principles involved, instruction in physiology is best given after those sciences have been studied. The fact that large numbers of pupils leave school by the time the second year of high school is reached has, however, been a factor in assigning the subject its present positions in the grades and high school, since it was felt that the greatest working knowledge of hygiene possible was the only thing compatible with a happy working life. Yet here we encounter a criticism which the writer himself has verified by means of psychological tests—that the present day high school instruction in physiology adds but little save anatomical detail and technical terminology to the previous knowledge received in the grades. This fact by no means must be considered justification for wasting the pupil's time, for it is possible to form a fair idea of the extent to which the knowledge of physiology secured in the earlier years may be built upon in a high school course, and the time thus saved made fully profitable to the pupil both from a practical and cultural standpoint.* When we reflect that nowadays nearly every periodical contains advertisements of courses on personal efficiency, corrective diet, exercises, etc., we may firmly say that if physiology does not add to that knowledge acquired in the grades, something is wrong either with the content of it as taught, or the method of teaching involved that greater benefit is not derived. Further, judging from the market which seems to exist for the type of publications indicated, many adolescents may be expected to appreciate more fully at a later age what is nothing more, fundamentally than elementary physiology and hygiene, with addition perhaps of some of the type of material I shall later suggest.

WHY SOME FAVOR DISPLACING PHYSIOLOGY

Here we may give also perhaps the most troublesome reason of all for the threatened disappearance of physiology from the course of instruction of the adolescent. It is troublesome because it is allied with one aspect of our national psychology—a prevalent narrow view that

education is purely for material return. Those who incline in this direction favor displacing the subject, because the time it takes under er immediate use to pupils as a moneymaker. They reason further that a person having the fundamentals of an education can read as the conditions, could be occupied by a subject which would be of great-much physiology for himself as he has a mind to, but here they ignore what they would recognize as a truth in other branches, that such a subject to take hold must be driven home by a competent teacher and one with personality. Grade school teachers have such a multiplicity of duties to perform nowadays, that physiology, except in the case of unusually conscientious teachers, receives but little attention; on the other hand, the present administrative arrangements of the high school offer advantageous conditions under which effective instruction may be imparted.

We know that since the inception of physiology in the public schools, it has always had the one very practical object of improving the physical and consequently the mental health of the population at large. One very important and practical question growing out of our present situation may be stated. Are we to feel that the removal of physiology as a required subject from high schools, where it can be most effectively taught, will tend to lower in a future selective draft the percentage of physical defectives we know now exists among our population? If physiology has failed in connection, it becomes increasingly clearer that such has been due either to its content or the failure "to put it across". The minds of the people can only remain open on this question because with the exception of the noteworthy case later to be alluded to, there is no means of telling just how much better health instruction in physiology has brought to the country. Generally speaking, we know that of late years, longevity has increased with the general intelligence of the people, and the latter's knowledge of physiology and hygiene is largely the basis from which all our public health propaganda operates. In these subjects, the individual is taught why and how to take care of his health and, thereby, the large majority of American citizens. The situation as explained previously then reduces itself to the following, viz., physiology and hygiene must be taught so as to serve pressing needs of the people, and continued in the high school as a required subject. It is under fire for various reasons at present and it must demonstrate itself beyond a question of doubt to be of use to those studying it. As stated the only opportunities for readjustment to meet fair criticism seem to be in the method of teaching it, or in the economical reorganization of the subject material. The writer has already dealt with the first of these opportunities in the papers cited while the second seems to find its expression in the broad lines originally laid down in the nature of the subject as a composite and heterogeneous science. As a part of the high school course it may therefore include in its sphere any scientific material whatsoever which in our judgment tends to make healthier American citizens, which is capable of simple presentation in our public schools, and of expansion to meet involved problems of national hygiene.

The Possibilities of Physiology Teaching

Additionally by virtue of its position in the public schools, it may be made the medium whereby the inherited traditions of the race on moral, ethical, and national issues as favored by the soundest thought, may be transmitted to the younger members. With regard to these possible functions, we may point to one such achievement with which it has been deeply concerned, interesting because it illustrates how with the proper keynote, education may unite men, women and children of all grades of a society in a common cause against an abuse peculiar to all mankind. The important justification for the introduction of physiology and hygiene into the school curriculum was grave concern and agitation was felt over the increasing prevalence of alcoholism and addiction to narcotics at the time among the population of the infant nation, then in clothes far too big for itself, apprehensively eyed by old world autocracies and well aware of it. A study of the movement shows that to put these abuses under the present desired state of control required the best part of 100 years of organized effort on the part of the people, which efforts in their later stages used the medium of the public school course in physiology to get the facts appearing in the matter before all concerned. Thus the seed was sown to a constantly increasing harvest. In a similar manner may be attacked many another virulent national abuse, whatever its nature. As the subject of temperance under these circumstances appears to be inextricably interwoven with that of physiology, we may justifiably trace other issues upon which it has had an effect. Prohibition may be accused advantageously of being a species of paternalism wherein the nation takes care of a few unable to take care of themselves, but even in such a light it is an encouraging symptom of the regeneration of personal responsibility among the mass of Americans, that the personal inclinations of the minority must not be permitted to endanger the safety of the greater number. That is just the sentiment we desire for other dangers to our national hygiene. It will be surprising indeed, if at this time those supporting prohibition will relax their efforts on the behalf of proper temperance instruction in the schools. Considering the present indications such can remain as part of the instruction in the grades, but with physiology missing in the impressionable adolescent years—those nearest to the period when the temptation is apt to be encountered—much ground of their victory is apt to be lost. It ought to be remembered that, while it is thus seen that the problems of the maintenance of prohibition and high school physiology are closely related, it is clear that the highest educational ideals will now, as in the past, decry any temperance instruction unaccompanied by the study of and emphasis on the normal human body, or such other qualifying instruction as may relieve physiology of the charge of imparting what will always seem to some, fundamentally partisan or even warping ideals. We have also seen how physiology may justify itself at the present time by the inclusion of a somewhat different type of subject matter than in use at the present. If material can be found which will enlist the support of all those public spirited agencies which work for the common good through the individual, we may be more sure of the vital part physiology will play in the education of our boys and girls.

REGARDING MENTAL HYGIENE

As indicated, the trend of such a course would be largely what we recognize now as applied hygiene in enlarged and generalized aspects, to include the physical and mental hygiene of the individual and his relations along these lines to the other members of society, the whole to merge as an ultimate climax into the national hygiene really at the basis of our present day Americanization movement. As the content of physical hygiene in such a course is not difficult to infer (or a working program of it may be obtained from the other articles of the writer), we need not add other than that it should be primarily made clear that the need of Americanization is not alone confined to the mental attitude of the foreigner, that inasmuch as sound mind accompanies sound body, a large proportion of Americans are in need of physical and perhaps mental Americanization. With regard to mental hygiene, there may be presented a variety of elementary applied psychology such as the rules governing mental fatigue, association, methods of study, straight line thinking, recreations healthful and unhealthful, memory training and control of the thoughts, with emphasis on the great truth that physical actions are in direct correspondence with mental ones. It is felt that such a proposed content of the high school physiology course would contribute largely to the success of more peculiarly vocational subjects such as salesmanship which are now being taught in the high school. When the proper foundation has been given, the teacher may, even if permissible only by guarded, wholesome and corrective suggestions, draw attention to the problems growing out of unhealthy mental states which America as a nation of individuals possessing a mutual heritage of traditions, must eventually confront in order that these traditions may be maintained as in the past.

Some of these problems relate to sexual hygiene, and here the opportunity-appreciating teacher will find the ground broken by the public being put in a more receptive attitude through the work of the U. S. Public Health Service and the State Boards of Health. Another subtle and unhealthy mental state finds its expression in the rapidly falling birthrate of the best American stocks, due apparently as much to selfishness and disregard for our country's future as to economic conditions. As a conseqence of such a situation, the nation is being infiltrated by inferior southern European stocks, our people acquiring their similar mercurial character, while steadily losing the Anglo-Saxon spirit of resolution and responsibility which has sped the republic in the past. Economical manifestations, such as the extravagance which has made us known as the world's best spenders together with the depletion of our natural resources may be similarly referable to mental states. A great deal of such desirable insight may be closely allied with the pupil's work in civics and other branches of the high school curriculum. In our quest for Americanization through the avenues of physical and mental hygiene, we need no better model or directions for conduct, than to go back to the lives of our forefathers, simple thrifty ones, with greater abundance of physical labor, personal responsibility and above all, large families. Such indeed was the physical manifestation of the spirit of '76, '12, '61, and if America wishes the foreigner to grasp the straight line thinking

responsible for such lives, she will have to furnish satisfactory examples, or some day face unpleasant consequences.

PHYSIOLOGY UNLIMITED AS A MEDIUM OF INSTRUCTION

With such broad objectives, it is hard to perceive the limits of the high school course in physiology in our evolving system of education, and we see more clearly how it may be made the medium of instruction by legitimate bodies having as their aim the improved welfare of America. Such a subject offers opportunities to those teachers who can conceive all other knowledge as serving a function of it, and to those administrators who possess the true *noblesse oblige* to all related to them in their work, for such information is what the earnest American should have in order that he may help his country. We see the need of positive educators of this type when we remember that the smaller number of our national evils may be reached directly by legislation, but all through sentiment starting in the public schools. It will then be granted that in every public school where such is possible, there should be at least one teacher (and who other but the physiology teacher) to keep the other teachers and the Parent-Teachers Association informed of the progress of all those organizations at work in our country on the improvement of the great mass of society and from time to time, as opportunity presents, incorporate the results of their work in the instruction. Such a suggestion is in full accord with one ideal of the true teacher's life—that of public leadership. The public has but lately learned that it has paid dearly, when in an effort at economy, the tremendous burden of routine clerical work in the schools, which might have been done more acceptably by those with less mental qualifications, was placed upon teachers. In exchange, their greater value to society, consistent as it is with the highest traditions of the profession, would have been or still may be public leadership in all questions affecting our national welfare. The most efficient action of the public to remedy such a blunder may be made at this time, when the most mercenary teachers have left the profession for good, and the most suitably qualified may be brought back to their worthy opportunities.

CORRESPONDENCE COURSES IN GENERAL SCIENCE

A course on the teaching of general science has for some years been offered in the summer sessions of our colleges and normal schools, and now we find that general science is entering the correspondence course field.

Since the fall of 1919 the Correspondence Study Department of the University of Chicago has been offering a course in "The Teaching of General Science Courses." This is in charge of Professor Charles J. Pieper. This year the Correspondence Study Department of the University of Pittsburgh, is offering a general science teachers course. This is under the direction of Mr. W. W. D. Sones, of the Department of General Science, Schenley High School. These courses are particularly valuable to beginning and prospective general science teachers, and experienced teachers will find both inspiration and practical helps from them.

Book Review

Common Science—Carlton W. Washburne—390 pages—191 illustrations—$1.60—World Book Company.

The foundation on which this book was built is a collection of about 2,000 questions asked by pupils in the upper elementary grades. The questions were classified according to the scientific principles involved, and the development of these principles gives the subject matter scientific unity and logical sequence.

It seems rather singular that these pupils asked no questions of a biological nature for the book deals entirely with physical science, as the chapter headings show:—Gravitation, Molecular Attraction, Conservation of Energy, Heat, Radiant Heat and Light, Sound, Magnetism and Electricity, Mingling of Molecules, Chemical Change and Energy. solution and chemical action, Analysis. Common Science is written in the language of children. It is full of interesting stories and experiments. It makes real use of the child's imagination, yet, through all, its science is reliable and accurate. Science knowledge is applied to the solution of everyday problems and the principles themselves are built on the child's observation of familiar phenomena. There are over 100 fasinating experiments and the apparatus required is simple and inexpensive. The illustrations are for the most part photographs of pupils performing experiments. These are very attractive, however, one might question whether so many should be used to the exclusion of diagrams, which are not very numerous in the book. It is, without doubt, a book that will appeal to students in the Junior High School.

Biology: General and Medical—Joseph McFarland, M. D.—4th edition—473 pages—151 illustrations—$2.50—W. B. Saunders Company.

This book treats living substance from its probable simplest beginnings to its highest complexity. It treats subject matter of principal interest and importance to medical students. Special mention should be made of topics presented at greater length than in usual biological writings: blood-relationship, infection, inmunity, parasitism, inheritance, mutilation, regeneration, grafting and senescence. The book is of college grade, but the general reader will get much help from it.

Practical Chemistry—Black and Conant—474 pages—257 illustrations—The Macmillan Company.

Practical chemistry is a text that will "make good." While, the subject matter does not differ materially from our other high school texts, it does have a freshness and a decided trend towards practical life that holds the interest. It is a book that can be used for college entrance classes, as well as for those who do not intend to go to college.

The chapters are summarized and followed by questions and problems. One desirable feature not found in other texts is the "Topics for Further Study" at each chapter end. Questions on each topic are given, followed by definite references.

Practical Physics—Millikan, Gale and Pyle—462 pages—465 illustrations—Ginn & Company.

This is a revision of Millikan & Gale's "First Course in Physics." The old organization has been retained but extensive changes in both subject matter and treatment have been made. The addition of a large number of full page illustrations of aircraft, big guns, the gas mask, the liberty motor, the automobile, the gyro-compass, the tank,

x-ray, and wireless devices will make a strong appeal to high school students.

The attractiveness of this new edition and its excellence of material will continue the well deserved popularity of the Millikan & Gale Physics.

Terman Group Test of Mental Ability—Lewis M. Terman. Examination booklets (12 pages) Forms A and B with ten tests each and with 185 items each, Scoring Keys for both forms, and a Manual of Directions (8 pages). Price per package of 25 booklets including Scoring Key and Manual of Directions $1.60 net. World Book Company.

This test is unique in many respects. It is especially designed for high schools, though it may be used as low as Grade 6 and as high as the freshman year in college. Each of its 886 items was measured against a very complete, composite outside criterion. Tryouts resulted in a reduction to 370 items, each helping to differentiate bright pupils from dull ones. The items retained are thus more highly selected than will be found in any other group mental test. The test can be given in thirty-five minutes.

Manual and Notebook to Everyday Science—W. H. Snyder—190 pages—161 experiments—Allyn & Bacon.

The latest laboratory manual in General Science to appear is this attractive, small size, loose-leaf manual. It is an excellent list of pupil experiments and teacher demonstrations to accompany the author's text. There are blank spaces for the pupils notes. This book should serve to stimulate classes and teachers to plan for more laboratory work in their elementary science classes.

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